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II. Solution by J. C. CORBIN, Pine Bluff, Arkansas ; P. S. BERG, Larimore, North Dakota ; E. W. MORRELL, Montpelier Seminary, Montpelier, Vermont ; A. P. READ, A. M., Clarence, Missouri ; and O. S. WESTCOTT, Principal North Chicago High School, Chicago.

Put  $N=nD+1$ , then it is evident that if  $N=nD+1$  be raised to any positive integral power, the last term will be 1 and every other term will contain  $D$  as a factor ; hence if this power be divided by  $D$  the remainder will be 1.

Also solved in a similar way by A. H. BELL, JOSIAH H. DRUMMOND, ARTEMAS MARTIN and J. SCHEFFER.

III. Solution by J. O. MAHONEY, B. E., M. S., Graduate Fellow and Assistant in Mathematics, Vanderbilt University, Nashville, Tennessee.

If  $a \equiv a'$ ,  $b \equiv b'$ ,  $c \equiv c'$ ,  $d \equiv d'$ , etc., mod( $D$ ),

then  $abcd \dots \equiv a'b'c'd' \dots \text{mod}(D)$ .

Let  $a=b=c=d$ , etc.,  $=N$ , and  $a'=b'=c'=d'$ , etc.,  $=1$ , then  $N^k \equiv 1 \text{ mod}(D)$ .

## AVERAGE AND PROBABILITY.

Conducted by B. F. FINKEL, Springfield, Mo. All contributions to this department should be sent to him.

## SOLUTIONS OF PROBLEMS.

39. Proposed by O. W. ANTHONY, M. Sc., Professor of Mathematics, Columbian University, Washington, D. C.

A man is at the center of a circular desert ; he travels at a given rate but in a *perfectly* random manner. What is the probability that he will be off the desert in a given time?

No solution of this problem has been received.

40. Proposed by HENRY HEATON, M. Sc., Atlantic, Iowa.

If every point of an ellipse be joined with every other point, what is the average length of the chords thus drawn ?

Solution by the PROPOSER.

Let  $a \cos \theta$  and  $(b/a) \sin \theta$  be the coördinates of one point, and  $a \cos \phi$  and  $(b/a) \sin \phi$  those of another.

The length of the chord joining them is

$$K = [a^2 (\cos \phi - \cos \theta)^2 + \frac{b^2}{a^2} (\sin \phi - \sin \theta)^2]^{\frac{1}{2}}.$$

Let  $s_1$  and  $s_2$  = lengths of elliptic arcs from point  $(a, 0)$  to points  $(a \cos \theta, \frac{a}{b} \sin \theta)$  and  $(a \cos \phi, \frac{a}{b} \sin \phi)$  respectively, and let  $S$  = whole distance around the ellipse.

Then  $\frac{ds_1}{d\theta} = a(1 - e^2 \cos^2 \theta)^{\frac{1}{2}}$  and  $\frac{ds_2}{d\phi} = a(1 - e^2 \cos^2 \phi)^{\frac{1}{2}}$ .

Then the required average is

$$A = \frac{H}{S^2} \int_0^{2\pi} \int_0^{2\pi} K ds_1 ds_2 = \frac{4a^2}{S^2} \int_0^{2\pi} \int_0^{2\pi} \left[ a^2 (\cos \phi - \cos \theta)^2 + \frac{b^2}{a^2} (\sin \phi - \sin \theta)^2 \right]^{\frac{1}{2}} \times \\ (1 - e^2 \cos^2 \theta)^{\frac{1}{2}} (1 - e^2 \cos^2 \phi)^{\frac{1}{2}} d\theta d\phi.$$

This equation cannot be integrated in general terms.

Solved in the same manner by *G. B. M. ZERR*,

41. Proposed by *F. P. MATZ*, Sc. D., Ph. D., Professor of Mathematics and Astronomy in Irving College, Mechanicsburg, Pennsylvania.

A line is drawn at random across the chord and given arc of a circular segment. Find the mean area of the divisions.

Solution by *G. B. M. ZERR*, A. M., Ph. D., Texarkana, Arkansas-Texas.

Let  $A$  = area of given segment,  $A_1, A_2$  mean areas of the two divisions.

$\therefore A_1 + A_2 = A$ .

But, since the line is a random line,  $A_1 = A_2$ .

$\therefore A_1 = A_2 = \frac{1}{2}A$ .

Also solved by *HENRY HEATON*.

42. Proposed by *CHARLES E. MYERS*, Canton, Ohio.

A attends church 4 Sundays out of 5; B, 5 Sundays out of 6; and C, 6 Sundays out of 7. What is the probability of an event that A and B will be at church and C will not?

Solution by *G. B. M. ZERR*, A. M., Ph. D., Texarkana, Arkansas-Texas, and *B. F. FINKEL*, A. M., Professor of Mathematics and Physics, Drury College, Springfield, Missouri.

The chance that A attends church =  $\frac{4}{5}$ .

The chance that B attends church =  $\frac{5}{6}$ .

The chance that C attends church =  $\frac{6}{7}$ .

The chance that A is not at church =  $\frac{1}{5}$ .

The chance that B is not at church =  $\frac{1}{6}$ .

The chance that C is not at church =  $\frac{1}{7}$ .

The chance that A and B attend and C not =  $p_1 = \frac{4}{5} \cdot \frac{5}{6} \cdot \frac{1}{7} = \frac{2}{21}$ .

The chance that A and C attend and B not =  $p_2 = \frac{4}{5} \cdot \frac{6}{7} \cdot \frac{1}{6} = \frac{4}{35}$ .

The chance that B and C attend and A not =  $p_3 = \frac{5}{6} \cdot \frac{6}{7} \cdot \frac{1}{5} = \frac{1}{7}$ .

The chance that A attends and B and C not =  $p_4 = \frac{4}{5} \cdot \frac{1}{6} \cdot \frac{1}{7} = \frac{4}{210}$ .

The chance that B attends and A and C not =  $p_5 = \frac{1}{5} \cdot \frac{5}{6} \cdot \frac{1}{7} = \frac{1}{42}$ .

The chance that C attends and A and B not =  $p_6 = \frac{1}{5} \cdot \frac{1}{6} \cdot \frac{6}{7} = \frac{1}{35}$ .

The chance that A, B and C attend =  $p_7 = \frac{4}{5} \cdot \frac{5}{6} \cdot \frac{6}{7} = \frac{4}{7}$ .

The chance that A, B and C do not attend =  $p_8 = \frac{1}{5} \cdot \frac{1}{6} \cdot \frac{1}{7} = \frac{1}{210}$ .

$p_1$  = probability required.

Also  $p_1 + p_2 + p_3 + p_4 + p_5 + p_6 + p_7 + p_8 = 1$ .

Also solved by *HENRY HEATON*.